

A New Species of *Phymastichus* (Hymenoptera: Eulophidae) Parasitic on Adult *Xyleborus perforans* (Coleoptera: Scolytidae) on Macadamia Trees in Hawai'i

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ABSTRACT. *Phymastichus xylebori* n. sp. is described as a parasitoid of adult *Xyleborus perforans* on macadamia trees in Hawai'i, with additional specimens known from Costa Rica and USA (South Carolina). A key is presented to the 2 known species of *Phymastichus*: *xylebori* and the African *coffea* LaSalle. Both species have potential value in biological control programs against scolytids.

INTRODUCTION

The eulophid subfamily Tetrastichinae is cosmopolitan in distribution, and not only contains a large number of species, but also displays a remarkable degree of variability in hosts and biology. Summaries of tetrastichine behavior and biology are given by Graham (1987) and LaSalle (1994). The genus *Phymastichus* was recently described in the Tetrastichinae for a single new species, *P. coffea*, which is a parasitoid of the coffee berry borer (*Hypothenemus hampei* (Ferrari), Scolytidae) in Africa (LaSalle 1990). This species was distinguished from other tetrastichines by morphological characters (LaSalle 1990; and below), as well as by a biological character: *P. coffea* attacks the adult stage of its host.

Despite the biological variety seen in this subfamily, no other tetrastichines are known to attack the adult stage of their host. Feldhege (1992) published a detailed account of the biology of *P. coffea*. Females place eggs into adult hosts in 3 ways: into the abdomen by ovipositing through a pore in the elytra; into the thorax; or between the thorax and the abdomen. The smaller males develop from eggs placed within the thorax; the larger females develop from eggs placed in the abdomen.

Recently, I received specimens of a second species of *Phymastichus* which attacks adult *Xyleborus perforans* (Wollaston). *Xyleborus perforans* is one of several species of *Xyleborus* which attack macadamia trees (*Macadamia integrifolia* Maiden & Betcher) in Hawai'i, and may be associated with macadamia quick decline (Chang 1993). A description of this new species is offered to provide a name for a species, which may be of economic interest and which has already been referred to in the literature as *Phymastichus* new species (Chang 1993).

There is presently no known overlap in host or distribution for the 2 species of *Phymastichus*, and it might appear that having biological or geographical information on a specimen would be sufficient for species identification. However, a key to the species is provided for the following reasons. First, it may be that these species actually do overlap now or will do so in the future. *Phymastichus xylebori* apparently is already widespread in distribution, and has perhaps travelled with its host tree which is now circumtropical, so it is possible that it also occurs in Africa. Also, both these species are candidates for use in biological control programs. *Phymastichus coffea*, while presently known only from Africa, may be introduced into areas where coffee berry borer is a problem, such as Southeast Asia and Central and South America; and *P. xylebori* might be similarly considered for the control of *X. perforans*. Second, the degree of polyphagy in either of these species is not clear. While *P. xylebori* is known to attack *X. perforans* in Hawai'i, no host information exists for this species from other areas where it has been collected.

The macadamia tree is native to Queensland, but has been spread throughout the world for commercial purposes (Mabberley 1987), and it is a particularly important crop in Hawai'i. *Xyleborus perforans* is known from throughout tropical regions of the world but was probably Oriental in origin. It is polyphagous, but is chiefly a pest on coconut, sugarcane, rubber, citrus, mango, avocado and *Eucalyptus*. Some further information on biology and hosts, as well as several references to detailed biological studies, was given by Booth *et al.* (1990). Because both macadamia and *X. perforans* are introduced to Hawai'i, it is probable that *P. xylebori* is not endemic either. Additional specimens of the latter species are also known from Costa Rica and USA, however host information for these specimens is unknown.

Morphological terminology follows LaSalle (1994). Acronyms for collections are as follows:

BMNH, The Natural History Museum, London, UK.

BPBM, Bernice P. Bishop Museum, Honolulu, Hawaii, USA.

CNC, Canadian National Collection, Ottawa, Canada.

INBio, Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica.

USNM, National Museum of Natural History, Washington, DC, USA.

Genus *Phymastichus* LaSalle

Phymastichus LaSalle, 1990: 7–9. Type species: *Phymastichus coffea* LaSalle (original designation).

Diagnosis. The discovery of *P. xylebori* necessitates a new diagnosis of the genus *Phymastichus*; which is slightly modified from that published by LaSalle (1990).

Forewing (Fig. 9) with parastigma slightly to distinctly swollen; submarginal vein with 1–3 setae on dorsal surface. Scutellum (Fig. 4) without submedian or sublateral lines; with anterior pair of setae placed in anterior half of scutellum, closer to anterior margin than to posterior pair of setae. Mesoscutum (Fig. 3) without median line.

Biology. Both species in the genus *Phymastichus* are parasitoids of adult scolytid beetles. *P. coffea* attacks *Hypothenemus hampei* on coffee in Africa; *P. xylebori* attacks *Xyleborus perforans* on macadamia in Hawaii. Further biological information is given for *P. coffea* by Feldhege (1992) and for *P. xylebori* by Chang (1993).

Discussion. The main characters that distinguish *Phymastichus* from other tetrastichines are given in the diagnosis. The best character remains the swollen parastigma, even though there is some variation in this character in *P. xylebori* and it is not always as distinctly swollen as in *P. coffea*. The only other genus of Tetrastichinae which has a swollen parastigma is *Paraspalangia* Girault, which differs in several other characters from *Phymastichus* (LaSalle 1994). In particular, *Paraspalangia* has a distinct petiole (petiole not visible in *Phymastichus*), and the distal part of the forewing infuscated except for a hyaline stripe near the apex of the stigmal vein (forewing completely hyaline in *Phymastichus*).

The biological character of attacking the adult stage of the host is considered to be a shared derived character to support the monophyly of the genus *Phymastichus*, and is an example of the value of using biological characteristics in systematics.

Key to species of the genus *Phymastichus* LaSalle

1 Last gastral tergite (female) in dorsal view with strong, step-like carina encompassing cerci; with many strong setae between cerci; and with peculiar scale-like sculpture anterior to carina on medial part of tergite (Figs. 5,6). Ovipositor, when visible, strong, flattened, blade-like (Figs. 7,8). At least hind coxa white to yellow, in distinct contrast to dark brown mesosoma (both sexes) *xylebori* sp.n.

1' Last gastral tergite normal; without carina, setae and scale-like sculpture as described above. Ovipositor usually hidden, if exposed then normal, not flattened. Coxae dark brown, concolorous with mesosoma (both sexes) *coffea* LaSalle

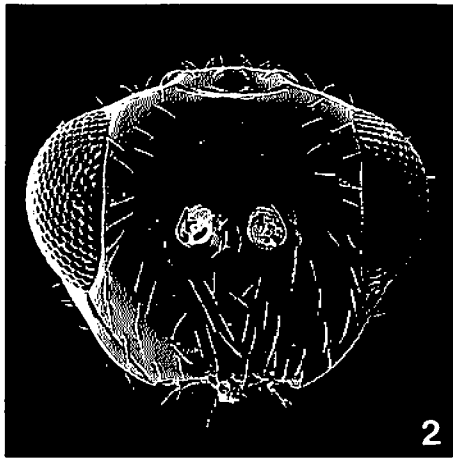
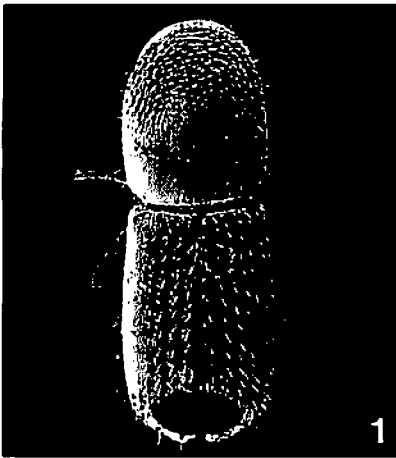


Fig. 1. *Xyleborus perforans* showing *Phymastichus xylebori* exit hole. Figs. 2-4. *Phymastichus xylebori*, ♀: 2, face; 3, mesosoma; 4, scutellum and propodeum.

Phymastichus xylebori LaSalle, sp.n. (Figs. 2–11)

Diagnosis. *P. xylebori* can be distinguished from other Tetrastichinae by the characters given in the generic diagnosis and key to species of *Phymastichus*. In particular, the characters of the last gastral tergite in the female (see key above, Figs. 5,6) make it easily recognizable, as these characters are not known in any other Tetrastichinae.

Female. Length 1.0–1.5 mm. Head, mesosoma and gaster dark brown, rarely almost black or with very slight metallic tinge. Scape and pedicel yellow, remainder of antenna brown. Coxae generally white to very light yellow, although occasionally darker (see discussion below); legs and tarsi yellow. Wings hyaline; veins brown, except the following areas often lighter: stigmal vein proximal to stigma, parastigma at junction of submarginal vein and proximal of swollen area.

Head (Fig. 2) without scrobal suture, with incomplete transverse frontal suture just ventral to median ocellus. Toruli placed above level of ventral margin of eye. Malar sulcus complete, straight. Clypeus not delimited by a suture, but its corner marked with a distinct anterior tentorial pit; clypeal margin bilobed.

Antenna (Fig. 10). Scape 3.6–4.2 × as long as wide. Pedicel 2.1–2.2 × as long as wide. Two anelli. All funicular segments at least slightly longer than wide; F1 1.7–2.2 × as long as wide, F2 and F3 1.25–1.5 × as long as wide. Club with a long terminal spine; 3.5–4.0 × as long as wide (measured from base of club to apex of terminal spine).

Mesosoma (Figs. 3–4). Mesoscutum without median line; with 3–4 adnotaular setae which are not placed in a particularly straight line. Scutellum with a series of distinct, strong, flange-like carina on each side lateral to where the sublateral line would normally be. Propodeum with a smooth, wide median carina. Fore and hind legs with first tarsal segment, in dorsal view, slightly shorter than second; middle leg narrower than other legs, with first tarsal segment (in dorsal view) distinctly longer than second segment.

Forewing (Fig. 9) with 2–3 setae on dorsal surface of submarginal vein. Parastigma usually distinctly swollen near junction with marginal vein, sometimes less swollen. Stigmal vein lighter in color than marginal vein and stigma. Postmarginal vein slightly developed, but still distinctly less than half as long as stigmal vein. Marginal vein 2.25–2.5 × as long as stigmal vein.

Gaster (Figs. 5–8). Last gastral tergite in dorsal view with a strong, step-like carina encompassing cerci; with many strong setae between cerci; with peculiar scale-like sculpture anterior to carina on the medial part of tergite. Hypopygium extending well past half the length of the gaster. Ovipositor, when visible, strong, flattened, blade-like. One of the cercal setae distinctly longer than remaining setae, and sinuate or curved.

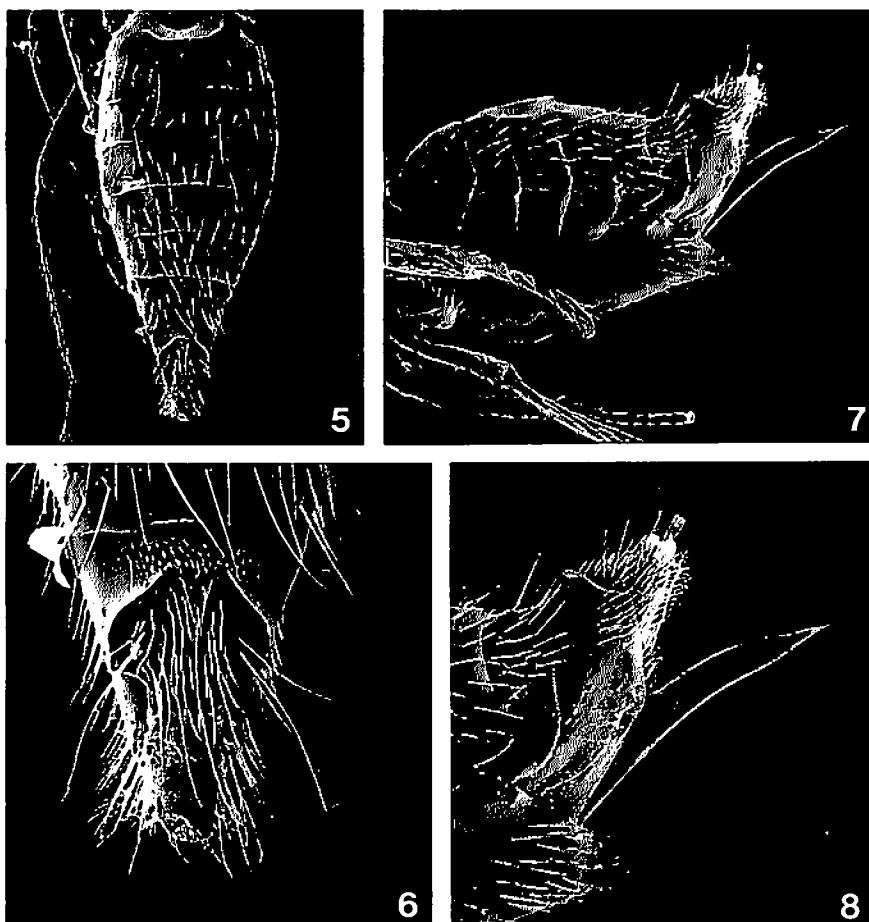
Male. Length 0.6–0.95 mm. Similar to female in coloration and general characters. Differences as follows:

Forewing with 1–2 setae on dorsal surface of submarginal vein. Parastigma not swollen, or only slightly and not very noticeably swollen. Antenna with 1 anellus and 4 funicular segments; F1 quadrate, F2–F4 all at least slightly longer than wide. Club 4.0–4.5 × as long as wide (measured from base of club to apex of long terminal spine). Funicular segments without basal whorls of long setae, although with many scattered setae whose length is about equal to the width of the funicle. Scape without a ventral sensory plaque.

Biology. Reared from adult *Xyleborus perforans* on macadamia tree; adults emerge through exit holes chewed in the posterior end of the beetle (Fig. 1). Further biological information is given by Chang (1993).

Distribution. Hawaii, Costa Rica, USA (South Carolina).

Material Examined. Holotype ♀, HAWAII, Hawai'i I, Kea'au, 19.xii.1991, V. Chang, ex. adult *Xyleborus perforans* on macadamia nut (BMNH). 12♂, 12♀ Paratypes.



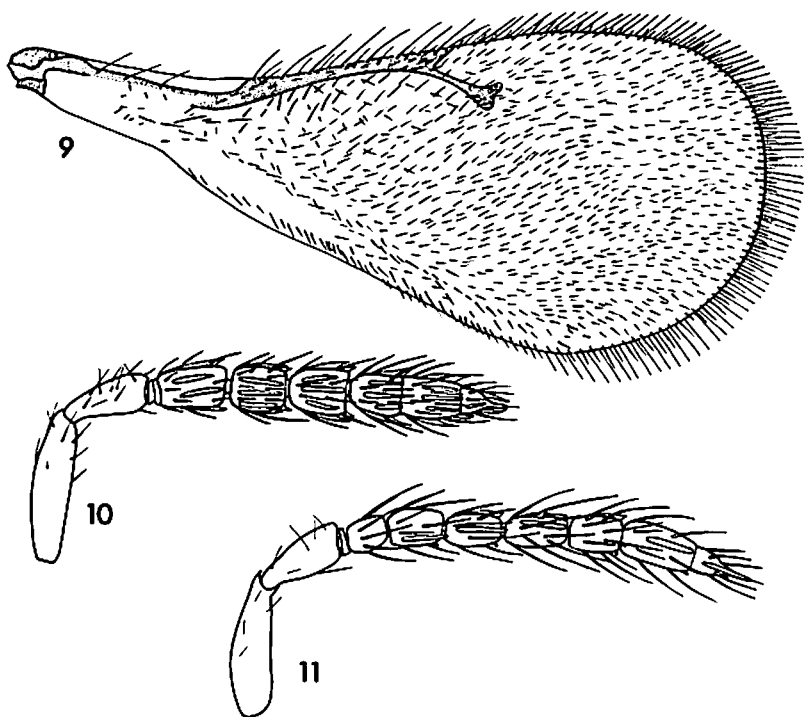
Figs. 5-8. *Phymastichus xylebori*, ♀: 5, gaster, dorsal view; 6, apex of gaster, dorsal view; 7, gaster, lateral view; 8, apex of gaster and ovipositor, lateral view.

Same data as holotype and 5.xii.1991 (6♂ 6♀ BMNH; 2♂ 2♀: BPBM, CNC, USNM).

Non-type material. COSTA RICA: Guanacaste Prov., Santa Rosa National Park, San Emilio 6-C, 2–23.iii.1986, D. Janzen & I. D. Gauld (1♀, BMNH); Guanacaste Prov., Santa Rosa National Park, Hacienda 4-C, 23.iii–13.iv.1986, D. Janzen & I. D. Gauld (1♀, INBio); Estralla Valley, Pandora, 1–28.iii.1984, H. Howden & G. Manley (1♀, CNC). USA: South Carolina, Anderson Co., Pendleton, 15–22.vii.1987, BRC Hym. Team (1♀, CNC).

Discussion. There is some variation in the amount of swelling of the parastigma in females. This swelling is always present, although it is more distinct in some specimens than others. In males, the parastigma is not swollen, or only slightly and not very noticeably swollen.

The male scape differs from that seen in most tetrastichines in that the ventral sensory plaque is absent. This plaque is found in virtually all male tetrastichines, and was used as a defining synapomorphy for the subfamily by Graham (1987). Males of *P. coffea* also lack this sensory plaque (LaSalle 1990), and the absence of this plaque, if it is a rever-



Figs. 9-11. *Phymastichus xylebori*: 9, ♀ forewing; 10, ♀ antenna; 11, ♀ antenna.

sal, may represent a synapomorphy for the genus *Phymastichus*.

The specimens from Costa Rica and South Carolina differ slightly from the Hawai'i specimens. In the Hawai'i specimens, all coxa are white, in contrast to the dark mesosoma; in the Costa Rica and South Carolina material, the fore coxa is dark, while the middle and hind coxa are white to yellow. This is a minor difference which suggests nothing more than intraspecific variation; however, these specimens are not included in the type series.

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